

# Extreme Astrophysics

Dr Martin Hendry  
Dept of Physics and Astronomy



UNIVERSITY  
of  
GLASGOW



**Extreme  
astrophysics:  
Jan 2007**

# Extreme Astrophysics

10 meetings, beginning 15/01/07

Course Aims:

From 'death stars' to superstrings, the universe abounds with phenomena of astonishing energy and power. In this course we will review our current understanding of the cosmos at its most extreme, exploring such topics as:

- The birth and death of stars: from nebulae to supernovae
- the awesome power of gamma-ray bursts
- pulsars, neutron stars and white dwarfs
- the search for gravitational waves
- when worlds collide: the threat of asteroid impact
- cosmic rays: ultra-energetic messengers from deep space
- a recipe for galaxy formation
- echoes of the Big Bang
- welcome to quantum gravity!



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# Extreme Astrophysics

## Course Lecturers:

Dr Martin Hendry

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University of Glasgow  
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*Plus (provisionally):*

Matt Pitkin

Bonnie Steves

Fiona Speirits

Alec Mackinnon

## Course Website:

<http://www.astro.gla.ac.uk/users/martin/teaching/extreme/>

username: extreme password: extreme

# Introduction: a primer on cosmic scales

## 1. The size of the universe

Our everyday unit of the metre quickly becomes unwieldy when we are describing cosmic distances.

We can, however, use **powers of ten** notation:

$$1 = 10^0$$

$$10 = 10^1$$

$$1000 = 10^3$$

$$1000000 = 10^6$$

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$$1000000 \text{ km} = 10^6 \text{ km}$$

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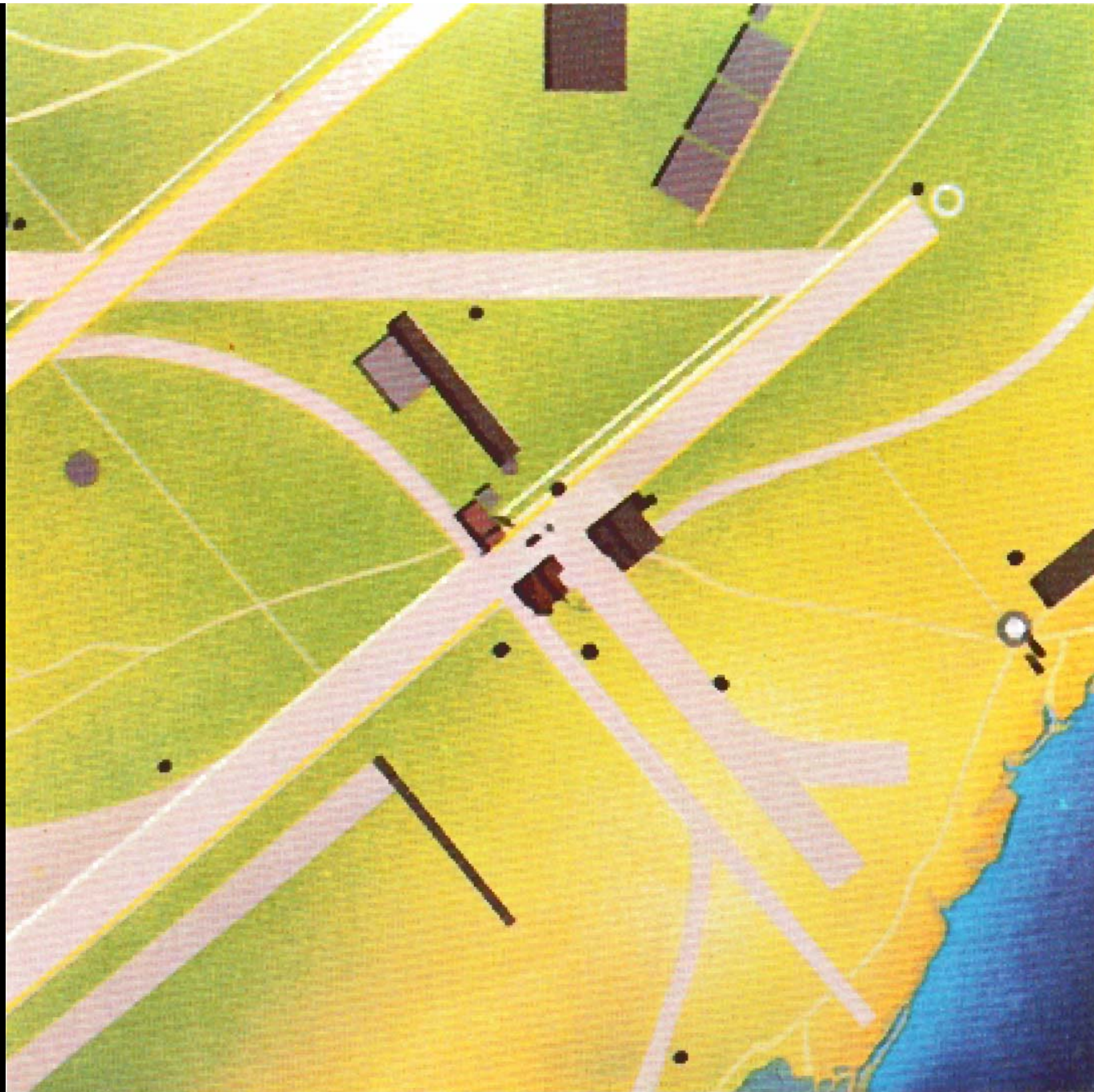
### SI prefixes

$10^n$	Prefix	Symbol	Short scale	Long scale	Decimal equivalent in SI writing style
$10^{24}$	yotta	Y	Septillion	Quadrillion	1 000 000 000 000 000 000 000 000
$10^{21}$	zetta	Z	Sextillion	Trilliard (thousand trillion)	1 000 000 000 000 000 000 000
$10^{18}$	exa	E	Quintillion	Trillion	1 000 000 000 000 000 000
$10^{15}$	peta	P	Quadrillion	Billiard (thousand billion)	1 000 000 000 000 000
$10^{12}$	tera	T	Trillion	Billion	1 000 000 000 000
$10^9$	giga	G	Billion	Milliard (thousand million)	1 000 000 000
$10^6$	mega	M		Million	1 000 000
$10^3$	kilo	k		Thousand	1 000
$10^2$	hecto	h		Hundred	100
$10^1$	deca, deka	da		Ten	10
$10^0$	<i>(none)</i>	<i>(none)</i>		One	1
$10^{-1}$	deci	d		Tenth	0.1
$10^{-2}$	centi	c		Hundredth	0.01
$10^{-3}$	milli	m		Thousandth	0.001
$10^{-6}$	micro	$\mu$ (u)		Millionth	0.000 001
$10^{-9}$	nano	n	Billionth	Milliardth	0.000 000 001
$10^{-12}$	pico	p	Trillionth	Billionth	0.000 000 000 001



1 1 km: low altitude flight





2 10 km: high altitude flight



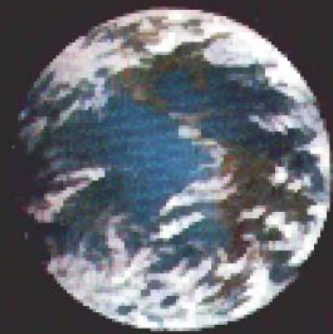
3 100 km: low orbit



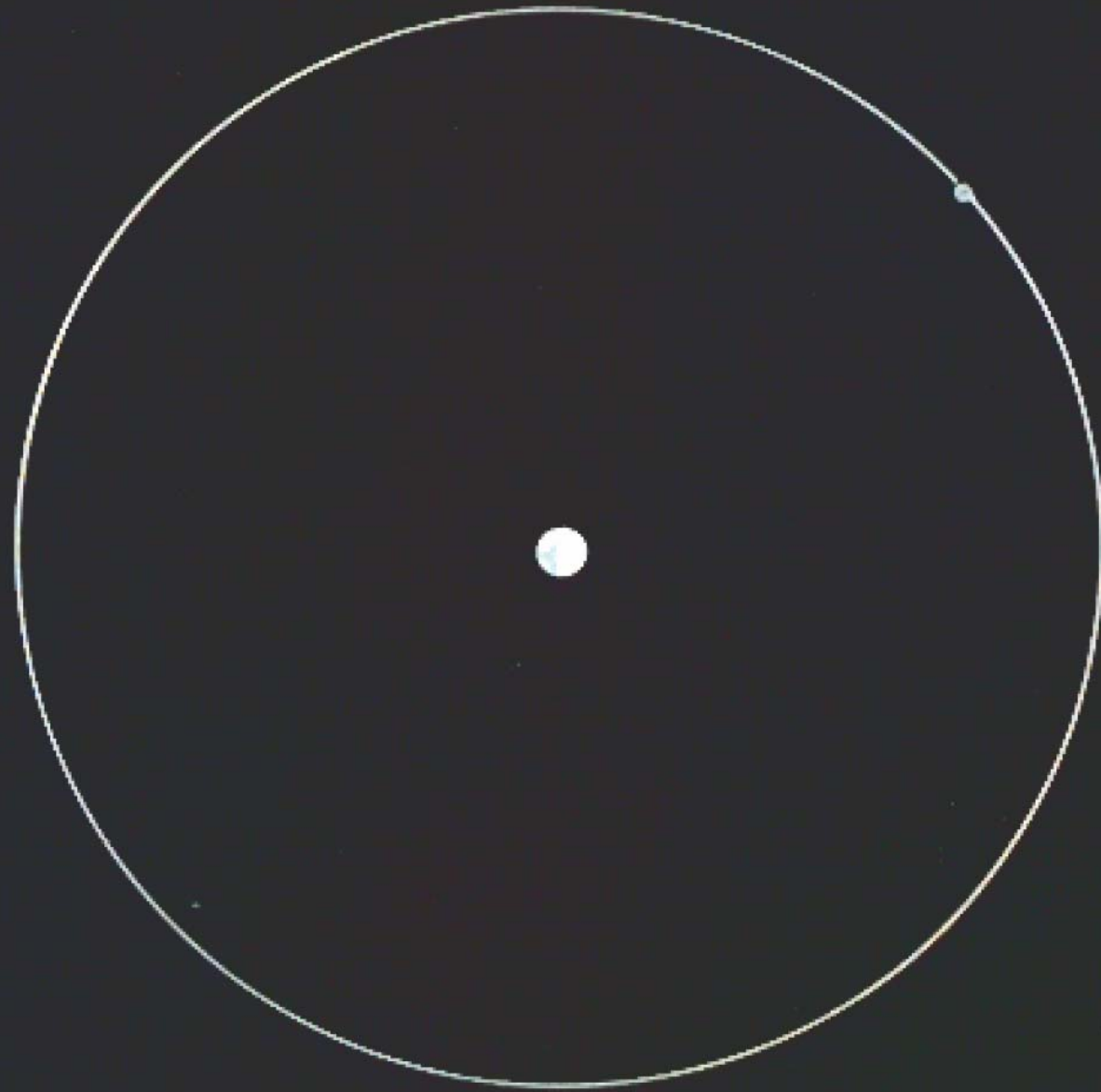
4 1000 km: mid-level orbit



5 10,000 km: high orbit



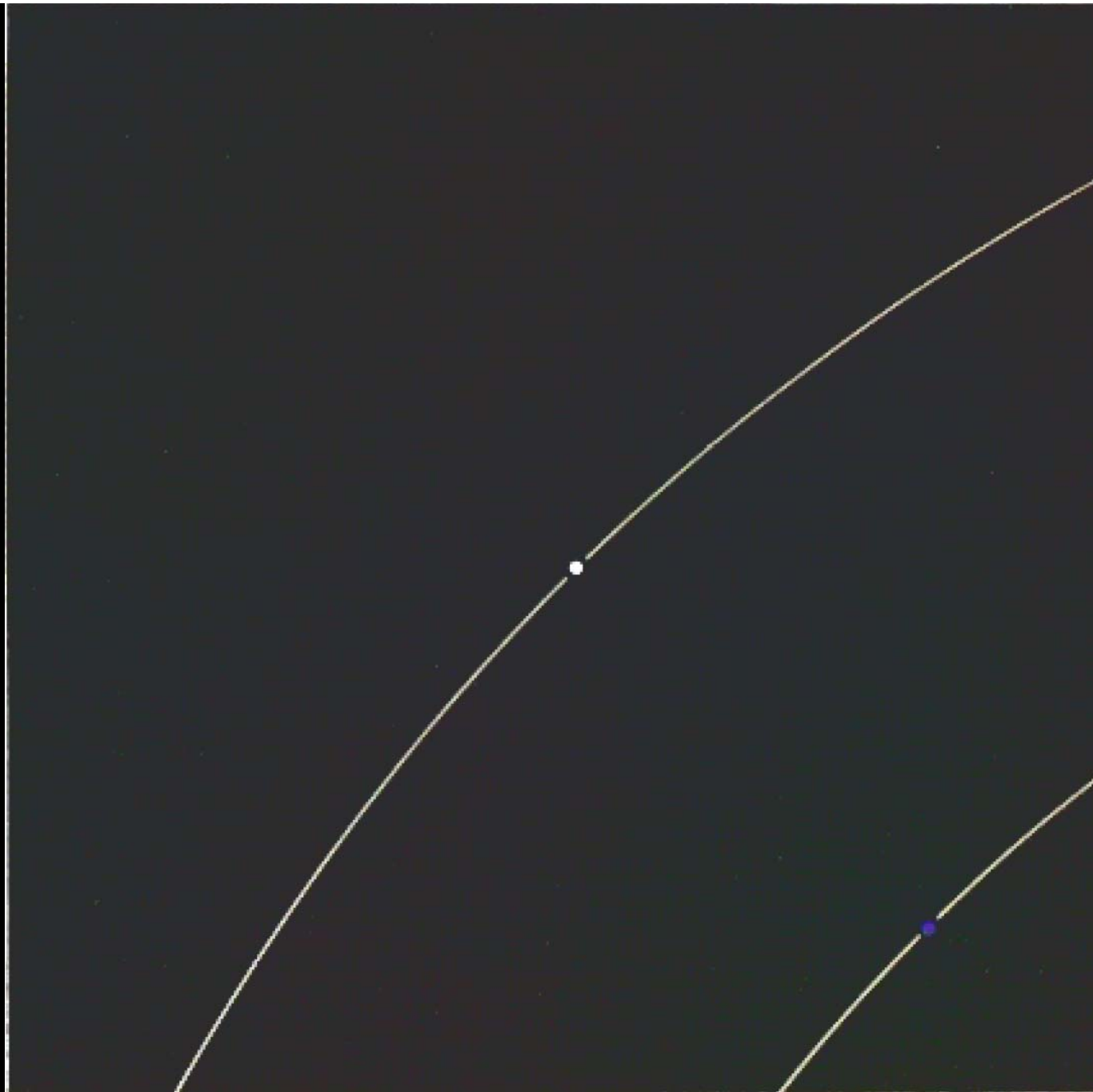
6 100,000 km : deep space



7 1 million km: Earth-Moon system

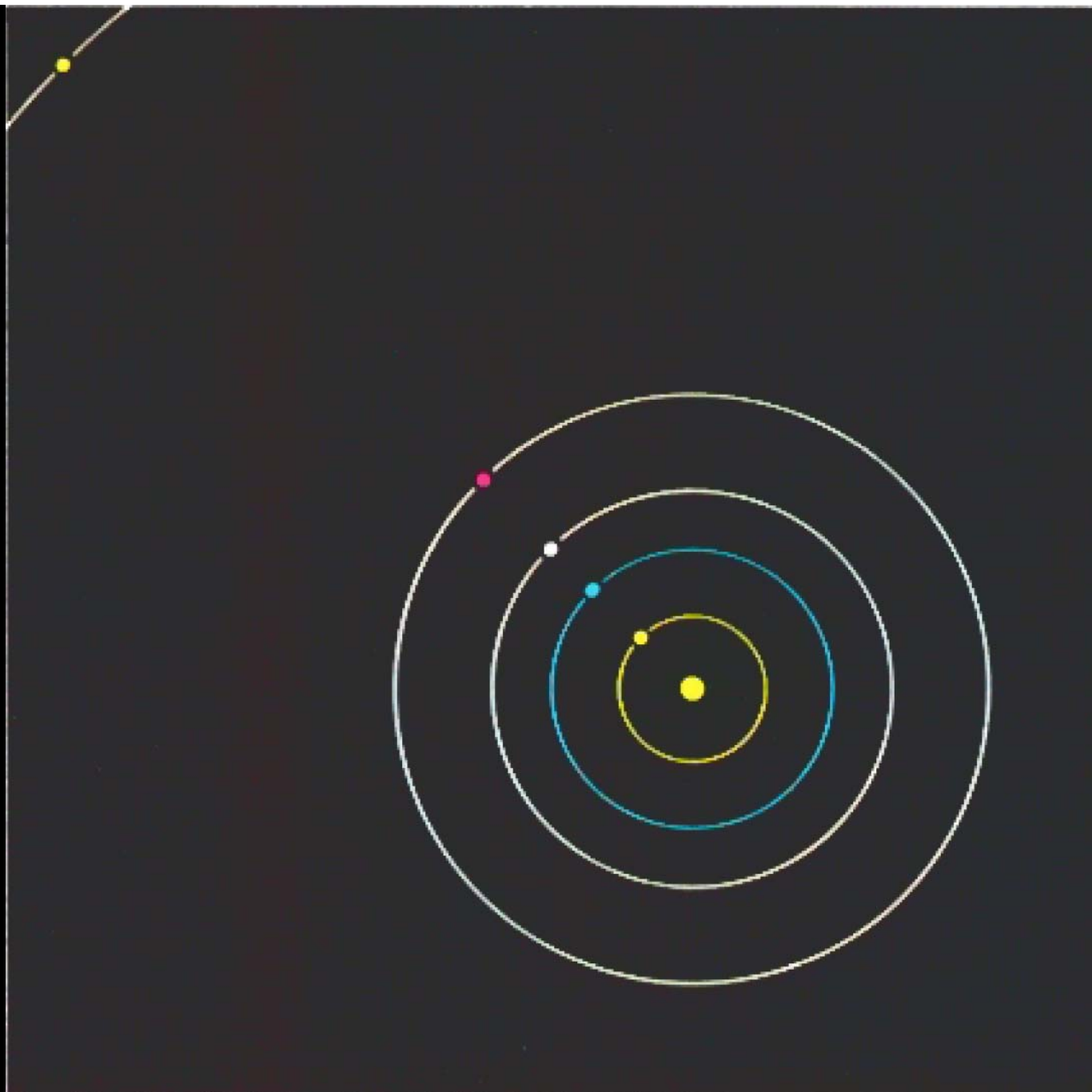


8 10 million km: interplanetary space

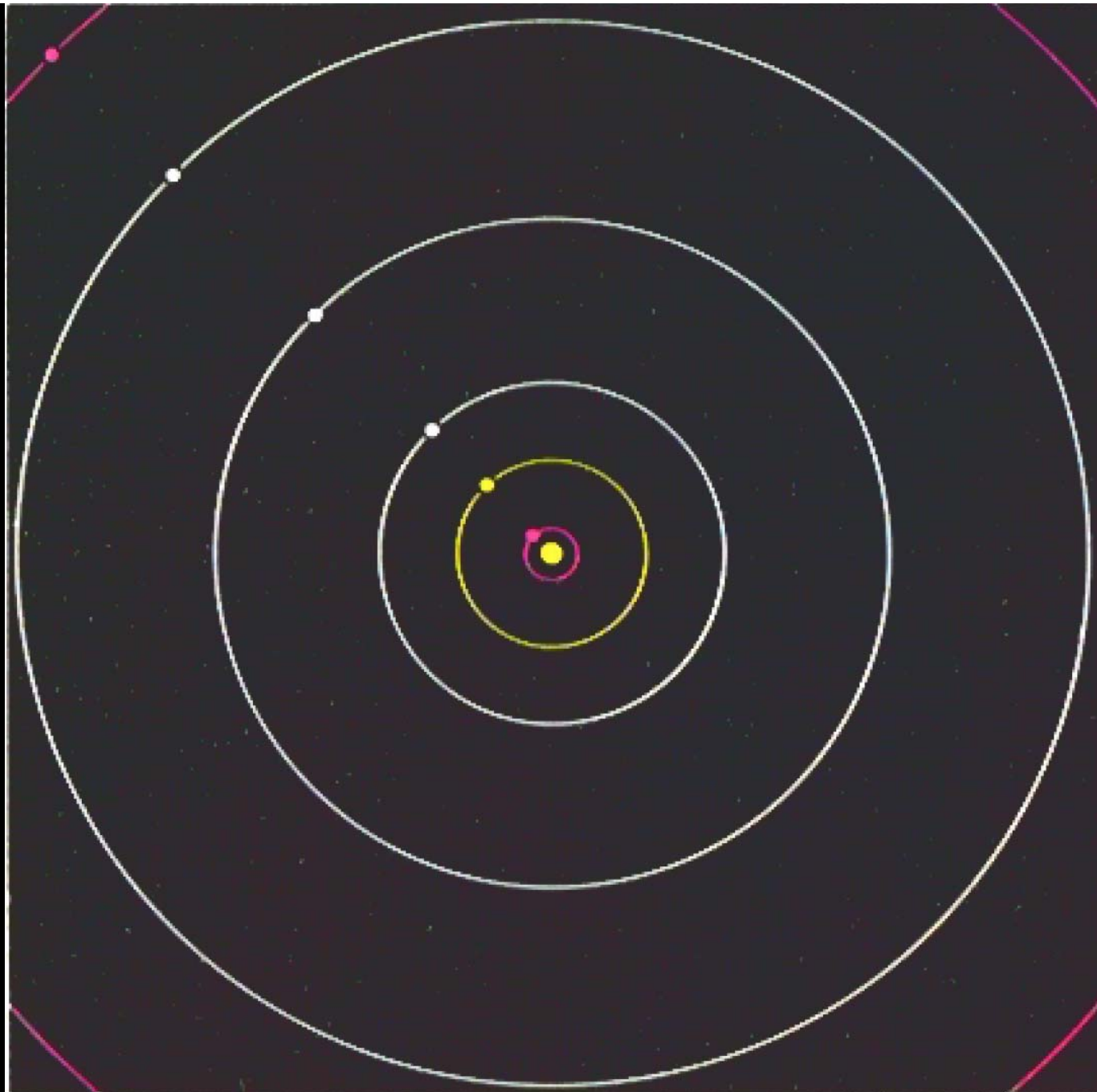


9 100 million km: from Earth (right) to Mars





10 1,000 million km: inner Solar System



11 10,000 million km: Solar System



12 100,000 million km: interstellar space



3 1 million million km: interstellar space

A dark, grainy image of interstellar space. A single bright star is visible in the center. The background is a dark, textured grey with many small, faint white specks representing distant stars or dust. The image is framed by black bars on the left and right sides.

14 10 million million km (1 light year): interstellar space



15 10 light years: local stars

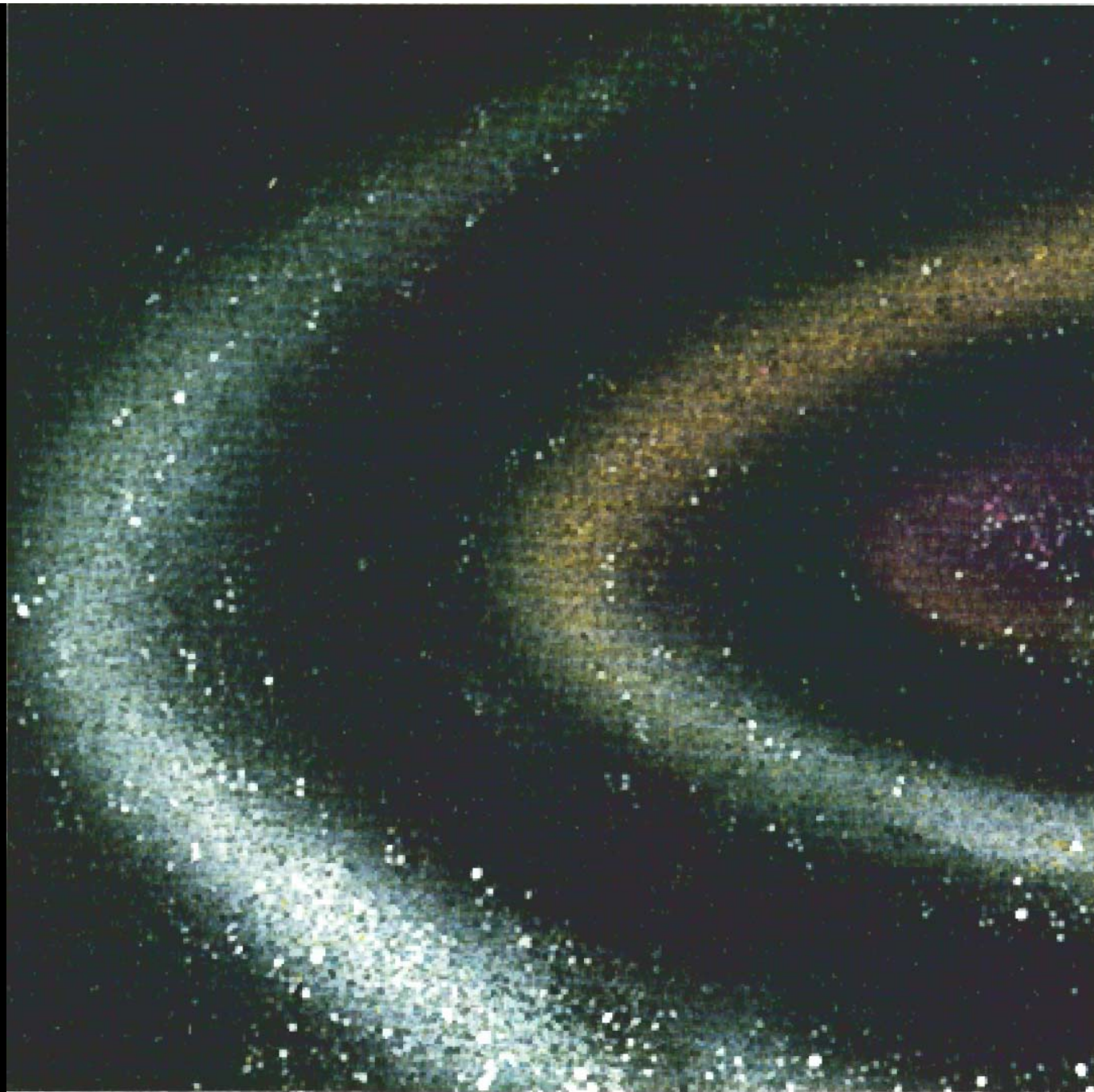


16 100 light years: local stars



7 1,000 light years: local region of galaxy





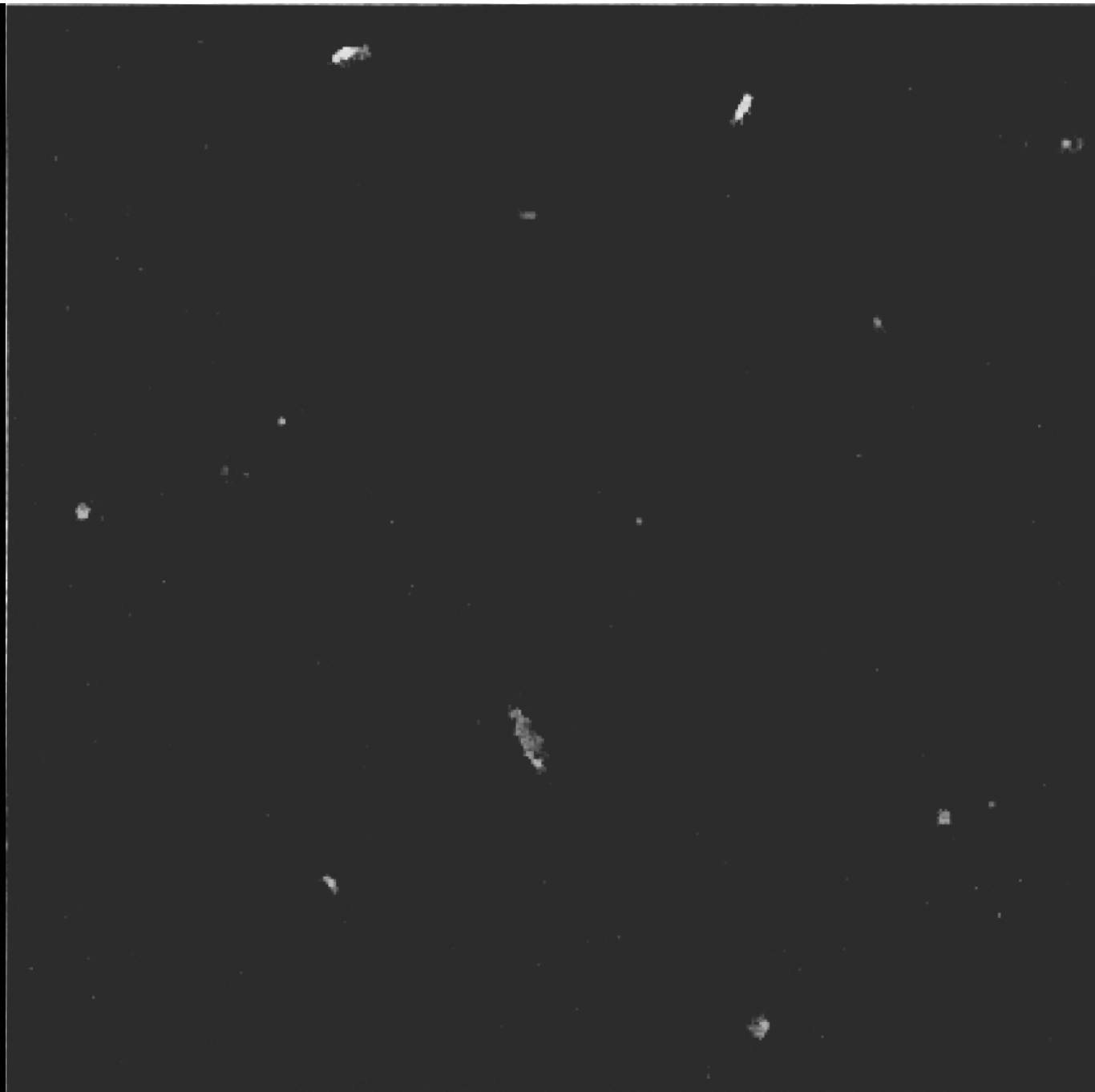
18 10,000 light years: arms of galactic spiral



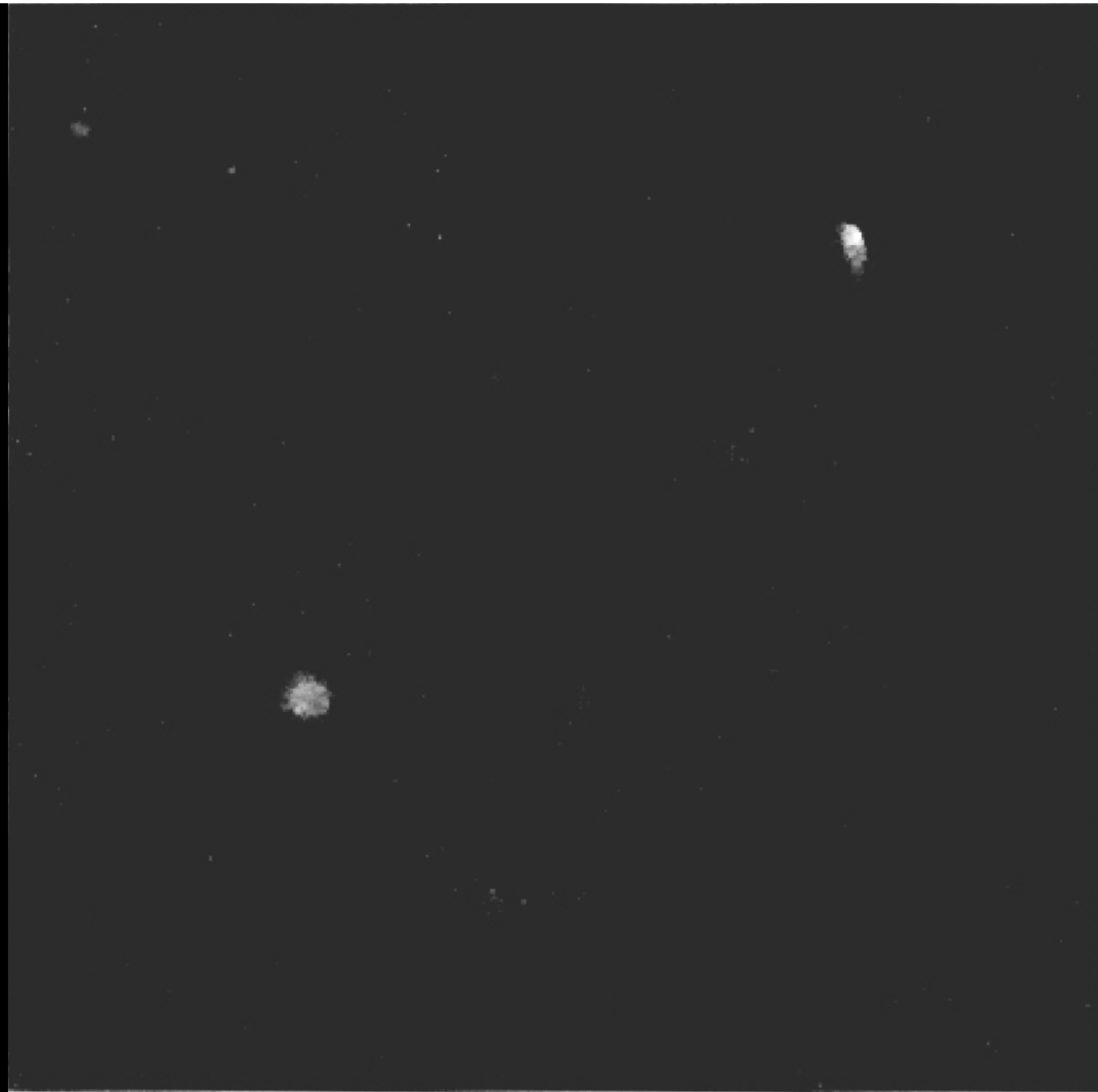
19 100,000 light years: Milky Way galaxy



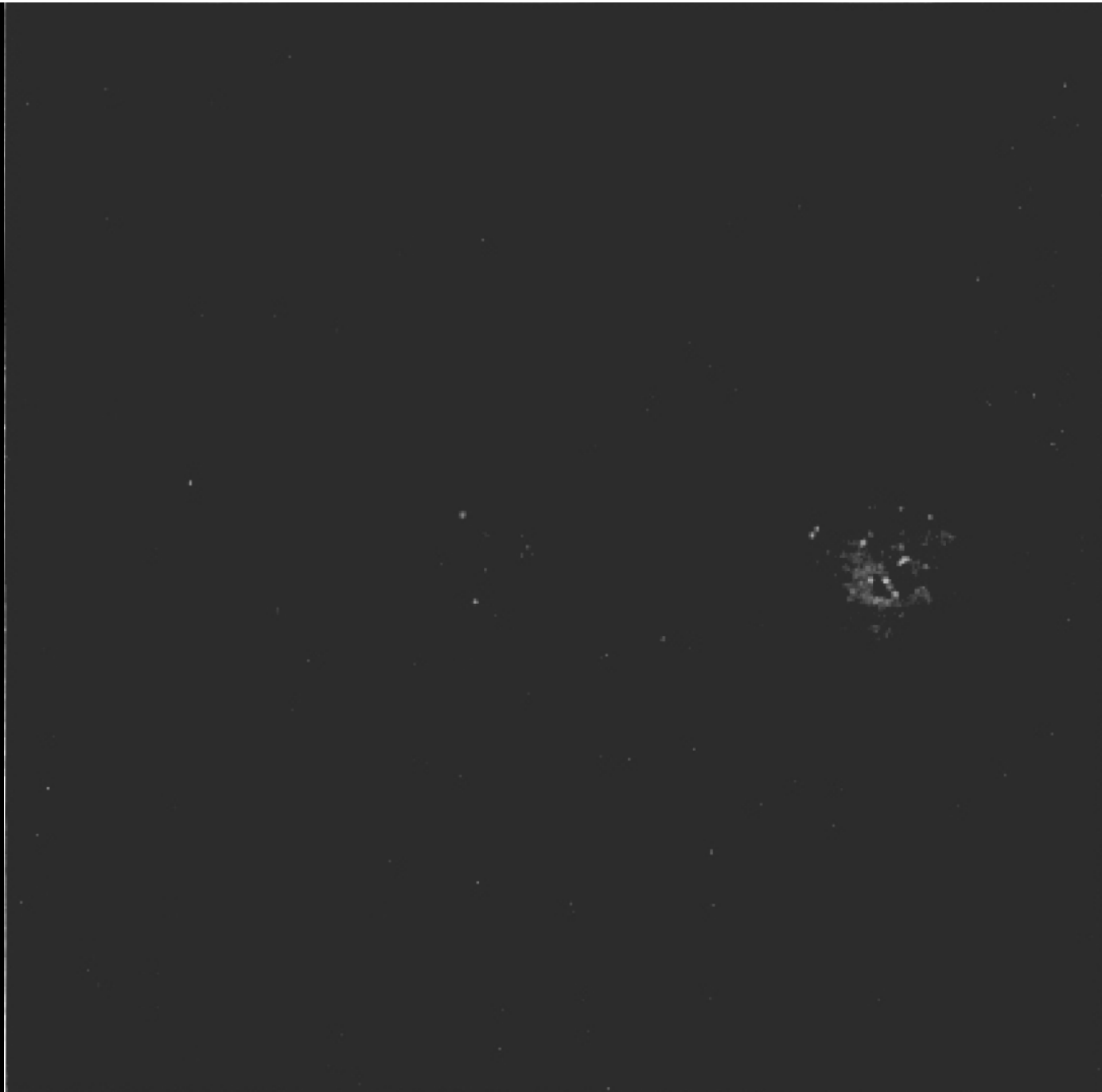
20 1 million light years: intergalactic space



21 10 million light years: local group of galaxies



22 100 million light years: galactic clusters



23 1,000 million light years: galactic clusters



24 10,000 million light years: limits of known universe

We can extend our 'map' of the Universe downwards to sub-atomic scales.

See e.g. wikipedia

[http://en.wikipedia.org/wiki/Orders\\_of\\_magnitude\\_\(length\)](http://en.wikipedia.org/wiki/Orders_of_magnitude_(length))

Other useful units:

**1 Astronomical Unit = 150 million km**

**1 parsec = 3.26 light years**

**= 206265 AU**